SYNTHESIS AND ANTI-MICROBIAL ACTIVITIES OF SOME 3-(4-PHENYLTHIAZOLE-2-YL) / 3-(3-CARBETHOXY-4,5,6,7-
TETRAHYDROBENZOTHIOPHENE-2YL) QUINAZOLIN-4(3H)-ONE

G.Saravanan*, V.Alagarsamy1, C.R.Prakash2, T.Panneer Selvam2, V.Karthick and P.Dinesh Kumar

*Medicinal Chemistry Research Lab, Bapatla College of Pharmacy, Bapatla(A.P), India.
1Medicinal Chemistry Research Lab, M.N.R. College of Pharmacy, Sangareddy (A.P), India.
2Department of Pharmaceutical Chemistry, D.C.R.M. Pharmacy College, Inkollu(A.P), India.
E.-mail: sarachem1981@gmail.com

ABSTRACT
In the present study, a novel quinazolin-4-(3H)-ones were synthesized by condensation of 2-amino-4-
phenylthiazole/2-amino-3-carbethoxy-4,5,6,7-tetrahydrobenzothiophene with 6,8-(un/mono/di)-bromo-2-
(methyl/phenyl)-4H-benzo-[1,3]-oxazine-4-ones. The 2-amino-4-phenylthiazole and 2-amino-3-carbethoxy-
4,5,6,7-tetrahydrobenzothiophene was synthesized from acetophenone and cyclohexanone respectively. The 6,8-
(un/mono/di)-bromo-2-(methyl/phenyl)-4H-benzo-[1,3]-oxazine-4-ones were synthesized from 3,5-
(un/mono/di)-bromo anthranilic acid. The chemical structures of the synthesized compounds were confirmed by
means of IR, 1H-NMR, Mass spectral and Elemental analysis. These compounds were screened for anti-bacterial
(Staphylococcus aureus ATCC 9144, Staphylococcus epidermidis ATCC 155, Micrococcus luteus ATCC 4698,
Bacillus cereus ATCC 11778, Escherichia coli ATCC 25922, Pseudomonas aeruginosa ATCC 2853, and
Klebsiella pneumoniae ATCC 11298) and anti-fungal (Aspergillus niger ATCC 9029 and Aspergillus fumigatus
ATCC 46645) activities by paper disc diffusion technique. The minimum inhibitory concentrations (MIC) of the
compounds were also determined by agar streak dilution method. Most of the synthesized compounds exhibited
mild to moderate anti-bacterial and anti-fungal activities. Among the synthesized compounds, 6,8-Dibromo-2-
methyl-3-(4-phenylthiazol-2-yl)-quinazolin-4(3H)-one (7c) was found to exhibit the highest anti-bacterial
activity and 6,8-Dibromo-2-methyl-3-(3-carbethoxy-4,5,6,7-tetrahydrobenzothiophene-2-yl)-quinazolin-4(3H)-
one (7f) exhibited highest anti-fungal activity.

Key words: Quinazolin-4-(3H)-one, Thiazole, Benzothiophene, Anti-bacterial and Anti-fungal.

INTRODUCTION
Heterocyclic chemistry comprises at least half of all organic chemistry research worldwide. In
particular, heterocyclic structures form the basis of many pharmaceutical, agrochemical and
Veterinary products. Quinazolin-4(3H)-ones1-5 are classes of fused heterocycles that are of
considerable interest because of the diverse range of their biological activities such as, anti-microbial,
anti-cancer, anti-convulsant, anti-tubercular, etc. In addition, several physiological activities such as
anti-bacterial, fungicidal, anti-spasmodic, analgesic and anti-tubercular of various thiazole6-8
derivatives have proved their efficacy in combating variety of diseases. A large number of
benzothiophene9,11 derivatives have been found to exhibit a wide variety of pharmaceutical activity
such as anti-microbial, anti-cancer and anti-HIV. The above observation stimulated our interest to,
synthesize a series of compounds containing quinazolin-4(3H)-one ring system associated with
thiazole/benzothiophene moiety and to evaluate their anti-microbial potency.

The synthetic strategy to synthesize the title compounds (7a-l) is depicted in scheme-1. In step 1,
acetophenone (1) is allowed to react with thiourea in presence of bromine to produce 2-amino-4-
phenyl thiazole (2). In step 2, cyclohexanone (3) was subjected to condensed with ethyleyanoacetate
and sulphur to produce 2-amino-3-carbethoxy-4,5,6,7-tetrahydrobenzothiophene (4). In step 3, 3,5-
(un/mono/di)-bromo anthranilic acid (X, X1 = H/Br) (5) were allowed to react with acetic
anhydride/benzoyl chloride in dry pyridine for cyclization to produce 6,8-(un/mono/di)-bromo-2-(methyl/phenyl)-4H-benzo-[1,3]-oxazine-4-one (6).

In step 4, the 6,8-(un/mono/di)-bromo-2-(methyl/phenyl)-4H-benzo-[1,3]-oxazine-4-ones (6) were allowed to react with 2-amino-4-phenyl thiazole (2) / 2-amino-3-carbethoxy-4,5,6,7-tetrahydrobenzothiophene (4) in dry pyridine to yield the title compounds (7a-l). Structural elucidation of synthesized compounds was attained by the aid of IR, 1H-NMR, mass spectral and elemental analysis. All the title compounds were screened for their anti-microbial activity against four gram positive bacteria (Staphylococcus aureus ATCC 9144, Staphylococcus epidermidis ATCC 155, Micrococcus luteus ATCC 4698 and Bacillus cereus ATCC 11778), three gram negative bacteria (Escherichia coli ATCC 25922, Pseudomonas aeruginosa ATCC 2853, and Klebsiella pneumoniae ATCC 11298) and two fungi (Aspergillus niger ATCC 9029 and Aspergillus fumigatus ATCC 46645). For preliminary screening, the anti-microbial tests were carried out by the paper disc diffusion technique. The minimum inhibitory concentrations (MIC) of the compounds were also determined by agar streak dilution method.

**EXPERIMENTAL**

Chemistry:
The melting points were determined on a MEL-Temp apparatus by open capillary tube method and are uncorrected. The IR spectra of the compounds were recorded on ABB Bomem FT-IR spectrometer MB 104 with KBr pellets. The 1H-NMR (300 MHz) spectra were recorded on a Bruker 300 NMR spectrometer with TMS as internal references. Mass spectra were recorded on Shimadzu GC MS QP 5000. Microanalyses were obtained with an elemental Analyses system GmbH VarioEL V300 element analyzer. The purity of the compounds was checked by TLC on pre-coated SiO2 gel (HF254, 200 mesh) aluminium plates (E Merk) using ethyl acetate: n-hexane as developing solvent and visualized in UV chamber. IR, 1H-NMR, Mass spectra and Elemental analysis were consistent with the assigned structures.

**Synthesis of 2-amino-4-phenyl thiazole (2):**
A mixture consisting of acetophenone (1) (0.1 mol) and thiourea (0.2 mol), add bromine (0.2 mol) drop wise very slowly. After the addition of bromine, the reaction mixture was heated on water bath for overnight, and water was added to it and again heated until most of the solid has gone into solution. The reaction mixture was filtered when it is hot and the filtrate was cooled. It was made alkaline with conc. ammonium hydroxide to separate 2-amino-4-phenyl thiazole 12. The product was filtered, washed with alcohol and dried over P2O5. It was recrystallised from ethanol, as colorless needles (2). Yield (84.2%), m.p. 120-122°C.

**Synthesis of 2-amino-3-carbethoxy-4,5,6,7-tetrahydro benzothiophene (4):**
To a mixture of cyclohexanone (3) (0.2 mol), ethylecyanacetate (0.2 mol) and sulphur (0.2 mol) in ethanol (40 ml), diethylamine (0.2 mol) was added drop wise with stirring. The 2-amino-3-carbethoxy-4,5,6,7-tetrahydro benzothiophene13 crystals (4) obtained are filtered and recrystallized from ethanol. Yield (89.5%), m.p. 119-121°C.

**Synthesis of 6,8-(un/mono/di)-bromo-2–(methyl/phenyl)-4H-benzo-(1,3)-oxazine–4-one (6):**
For the synthesis of 2-methyl derivative a mixture of 3,5-(un/mono/di)-bromo anthranilic acid (5a-c) (0.01mol) and acetic anhydride (0.1mol) was refluxed on gentle flame for 1 – 4 h. The excess of acetic anhydride was distilled off under reduced pressure and the residue was dissolved in petroleum ether and kept aside for 1h. The light brown solid (6a-c) which obtained was filtered and dried.
For the synthesis of 2-phenyl derivative to a solution of 3,5-(un/mono/di)-bromo anthranilic acid (5a-c) (0.1 mol) dissolved in pyridine (60 ml), benzoyl chloride (0.2 mol) was added. The mixture was stirred for 30 min followed by treatment with 5% NaHCO3 (115 ml). The solid (6d-f) obtained was recrystallized from ethanol.

**Synthesis of title compounds (7a-l):**
A mixture of 6a-f (0.02mol) and 2/4 (0.01mol) in dry pyridine (80 ml) was refluxed for overnight. After refluxing, the excess of solvent was removed and the residue was neutralized with HCl. The solid separated out was washed with water and recrystallised from ethanol to yield title compounds (7a-l). The physical data of the title compounds are depicted in Table-1.
Anti-microbial activity:
All the title compounds were screened for their anti-bacterial and anti-fungal activities. The anti-bacterial activity of the synthesized compounds was tested against four gram positive bacteria (*Staphylococcus aureus* ATCC 9144, *Staphylococcus epidermidis* ATCC 155, *Micrococcus luteus* ATCC 4698 and *Bacillus cereus* ATCC 11778) and three gram negative bacteria (*Escherichia coli* ATCC 25922, *Pseudomonas aeruginosa* ATCC and *Klebsiella pneumoniae* ATCC 11298) using nutrient agar medium (Hi-Media Laboratories, India). The anti-fungal activities of the compounds were tested against two fungi namely *Aspergillus niger* ATCC 9029 and *Aspergillus fumigatus* ATCC using sabouraud dextrose agar medium (Hi-Media Laboratories, India). For preliminary screening, the anti-microbial tests were carried out by the paper disc diffusion method. The minimum inhibitory concentrations (MIC) of the compounds were also determined by agar streak dilution method.

**Paper disc diffusion technique:**
The sterilized (autoclaved at 120 °C for 30min) medium (40-50 °C) was inoculated (1ml/100ml of medium) with the suspension (10⁵ cfu/ml) of the microorganism (matched to McFarland barium sulphate standard) and poured into a petridish to give a depth of 3-4 mm. The paper impregnated with the test compounds (100µg/ml in dimethyl formamide) was placed on the solidified medium. The plates were pre-incubated for 1 h at room temperature and incubated at 37 °C for 24 and 48 h for anti-bacterial and anti-fungal activities, respectively. Ciprofloxacin (100 µg/disc) and Ketoconazole (100 µg/disc) were used as standard for anti-bacterial and anti-fungal activities, respectively. The observed zone of inhibition is presented in Table-2.

**Minimum inhibitory concentration (MIC):**
MIC of the compound was determined by agar streak dilution method. A stock solution of the synthesized compound (100 µg/ml) in dimethyl formamide was prepared and graded quantities of the test compounds were incorporated in specified quantity of molten sterile agar (nutrient agar medium for anti-bacterial activity and sabouraud dextrose agar medium for anti-fungal activity). A specified quantity of the medium (40-50 °C) containing the compound was poured into a petridish to give a depth of 3-4 mm and allowed to solidify. Suspension of the microorganism were prepared to contain approximately 10⁵ cfu/ml and applied to plates with serially diluted compounds in dimethyl formamide to be tested and incubated at 37 °C for 24 h and 48 h for bacteria and fungi, respectively. The MIC was considered to be the lowest concentration of the test substance exhibiting no visible growth of bacteria or fungi on the plate. The observed MIC is presented in Table-2.

**RESULTS AND DISCUSSION**

**Chemistry:**

2-Methyl-3-(4-phenylthiazol-2-yl)-quinazolin-4(3H)-one (7a):
IR (KBr, cm⁻¹): 3017 (Ar-CH), 2915 (CH in CH₃), 1720 (C=O), 1518 (C=N), 1462 (C=C), 653 (C-S).

1H-NMR (CDCl₃) δ: 7.20-7.85 (m, 9H; C₅,C₆,C₇,C₈,C₂'',C₃'',C₄'',C₅'',C₆''); Ar-H), 6.71 (s, 1H; C₅'), 0.87 (s, 3H; C₂, -CH₃). EI-MS (m/z): 319 (Calcd for C₁₈H₁₃N₃OS; 319.38). Anal. Calcd for C₁₈H₁₃N₃OS: C, 67.69; H, 4.10; N, 13.16. Found: C, 67.60; H, 4.07; N, 13.11.

6-Bromo-2-methyl-3-(4-phenylthiazol-2-yl)-quinazolin-4(3H)-one (7b):
IR (KBr, cm⁻¹): 3041 (Ar-CH), 2920 (CH in CH₃), 1725 (C=O), 1514 (C=N), 1457 (C=C), 646 (C-Br).

1H-NMR (CDCl₃) δ: 7.18-8.07 (m, 8H; C₅,C₇,C₈, C₂'',C₃'',C₄'',C₅'',C₆''); Ar-H), 6.58 (s, 1H; C₅'), 0.89 (s, 3H; C₂, -CH₃). EI-MS (m/z): 398 (Calcd for C₁₈H₁₂BrN₃OS; 398.28). Anal. Calcd for C₁₈H₁₂BrN₃OS: C, 54.28; H, 3.04; N, 10.55. Found: C, 54.21; H, 3.00; N, 10.49.

6,8-Dibromo-2-methyl-3-(4-phenylthiazol-2-yl)-quinazolin-4(3H)-one (7c):
IR (KBr, cm⁻¹): 3032 (Ar-CH), 2926 (CH in CH₃), 1764 (C=O), 1522 (C=N), 1453 (C=C), 666 (C-Br).

1H-NMR (CDCl₃) δ: 7.05-7.99 (m, 7H; C₅,C₇,C₂'',C₃'',C₄'',C₅'',C₆''); Ar-H), 6.65 (s, 1H; C₅'), 0.95 (s, 3H; C₂, -CH₃). EI-MS (m/z): 477 (Calcd for C₁₈H₁₁Br₂N₃OS; 477.17). Anal. Calcd for C₁₈H₁₁Br₂N₃OS: C, 45.28; H, 3.04; N, 10.55. Found: C, 45.21; H, 3.00; N, 10.49.

2-Methyl-3-(3-carbethoxy-4,5,6,7-tetrahydrobenzothiophene-2-yl)-quinazolin-4(3H)-one (7d):
IR (KBr, cm⁻¹): 3040 (Ar-CH), 2926 (CH in CH₃), 1764 (C=O), 1522 (C=N), 1453 (C=C), 666 (C-Br).

1H-NMR (CDCl₃) δ: 7.05-7.99 (m, 7H; C₅,C₇,C₂'',C₃'',C₄'',C₅'',C₆''); Ar-H), 6.65 (s, 1H; C₅'), 0.95 (s, 3H; C₂, -CH₃). EI-MS (m/z): 477 (Calcd for C₁₈H₁₁Br₂N₃OS; 477.17). Anal. Calcd for C₁₈H₁₁Br₂N₃OS: C, 45.28; H, 3.04; N, 10.55. Found: C, 45.21; H, 3.00; N, 10.49.
6-Bromo-2-methyl-3-(3-carbethoxy-4,5,6,7-tetrahydrobenzothiophene-2-yl)-quinazolin-4(3H)-one (7e):
IR (KBr, cm\(^{-1}\))): 3018 (Ar-CH), 2912 (CH in CH\(_3\)), 1724 (C=O), 1532 (C=N), 1463 (C=C), 651 (C-S), 574 (C-Br). \(^1\)H-NMR (CDCl\(_3\)) \(\delta\): 7.47-7.99 (m, 3H; C\(_5\),C\(_7\),C\(_8\); Ar-H), 4.33 (tet, 2H; -CH\(_2\)), 1.53-2.60 (m, 8H; C\(_4\),C\(_5\),C\(_6\),C\(_7\)), 1.39 (tri, 3H; -CH\(_3\)), 0.87 (s, 3H; -CH\(_3\)). EI-MS (m/z): 447 (C\(_20\)H\(_{19}\)BrN\(_2\)O\(_3\)S; 447.35). Anal. Calcd for C\(_{20}\)H\(_{19}\)BrN\(_2\)O\(_3\)S: C, 53.70; H, 4.28; N, 6.26. Found: C, 53.61; H, 4.26; N, 6.19.

6,8-Dibromo-2-methyl-3-(3-carbethoxy-4,5,6,7-tetrahydrobenzothiophene-2-yl)-quinazolin-4(3H)-one (7f):
IR (KBr, cm\(^{-1}\))): 3046 (Ar-CH), 2920 (CH in CH\(_3\)), 1715 (C=O), 1524 (C=N), 1450 (C=C), 643 (C-S), 580 (C-Br). \(^1\)H-NMR (CDCl\(_3\)) \(\delta\): 7.69-8.06 (m, 2H; C\(_5\),C\(_7\); Ar-H), 4.26 (tet, 2H; -CH\(_2\)), 1.59-2.61 (m, 8H; C\(_4\),C\(_5\),C\(_6\),C\(_7\)), 1.35 (tri, 3H; -CH\(_3\)), 0.89 (s, 3H; -CH\(_3\)). EI-MS (m/z): 526 (C\(_{20}\)H\(_{18}\)Br\(_2\)N\(_2\)O\(_3\)S; 526.24). Anal. Calcd for C\(_{20}\)H\(_{18}\)Br\(_2\)N\(_2\)O\(_3\)S: C, 45.65; H, 3.45; N, 5.32. Found: C, 45.61; H, 3.39; N, 5.28.

2-Phenyl-3-(4-phenylthiazol-2-yl)-quinazolin-4(3H)-one (7g):
IR (KBr, cm\(^{-1}\))): 3048 (Ar-CH), 2932 (CH in CH\(_3\)), 1726 (C=O), 1513 (C=N), 1446 (C=C), 655 (C-S). \(^1\)H-NMR (CDCl\(_3\)) \(\delta\): 7.11-8.13 (m, 14H; C\(_5\),C\(_6\),C\(_7\),C\(_8\),C\(_2''\),C\(_3''\),C\(_4''\),C\(_5''\),C\(_6''\); Ar-H), 6.68 (s, 1H; C\(_5'\)). EI-MS (m/z): 381 (C\(_{23}\)H\(_{15}\)N\(_3\)O\(_3\)S; 381.45). Anal. Calcd for C\(_{23}\)H\(_{15}\)N\(_3\)O\(_3\)S: C, 72.42; H, 3.96; N, 11.02. Found: C, 72.39; H, 3.89; N, 10.99.

6-Bromo-2-phenyl-3-(4-phenylthiazol-2-yl)-quinazolin-4(3H)-one (7h):
IR (KBr, cm\(^{-1}\))): 3036 (Ar-CH), 2926 (CH in CH\(_3\)), 1722 (C=O), 1520 (C=N), 1460 (C=C), 647 (C-S), 564 (C-Br). \(^1\)H-NMR (CDCl\(_3\)) \(\delta\): 7.09-8.01 (m, 13H; C\(_5\),C\(_7\),C\(_8\),C\(_2''\),C\(_3''\),C\(_4''\),C\(_5''\),C\(_6''\); Ar-H), 6.61 (s, 1H; C\(_5'\)). EI-MS (m/z): 460 (C\(_{23}\)H\(_{14}\)BrN\(_3\)O\(_3\)S; 460.35). Anal. Calcd for C\(_{23}\)H\(_{14}\)BrN\(_3\)O\(_3\)S: C, 60.01; H, 3.07; N, 9.13. Found: C, 59.91; H, 3.02; N, 9.09.

6,8-Dibromo-2-phenyl-3-(4-phenylthiazol-2-yl)-quinazolin-4(3H)-one (7i):
IR (KBr, cm\(^{-1}\))): 3024 (Ar-CH), 2939 (CH in CH\(_3\)), 1720 (C=O), 1513 (C=N), 1446 (C=C), 655 (C-S), 577 (C-Br). \(^1\)H-NMR (CDCl\(_3\)) \(\delta\): 7.29-8.22 (m, 12H; C\(_5\),C\(_7\),C\(_2''\),C\(_3''\),C\(_4''\),C\(_5''\),C\(_6''\); Ar-H), 6.73 (s, 1H; C\(_5'\)). EI-MS (m/z): 539 (C\(_{23}\)H\(_{13}\)Br\(_2\)N\(_3\)O\(_3\)S; 539.24). Anal. Calcd for C\(_{23}\)H\(_{13}\)Br\(_2\)N\(_3\)O\(_3\)S: C, 51.23; H, 2.43; N, 7.79. Found: C, 51.17; H, 2.41; N, 7.75.

2-Phenyl-3-(3-carbethoxy-4,5,6,7-tetrahydrobenzothiophene-2-yl)-quinazolin-4(3H)-one (7j):
IR (KBr, cm\(^{-1}\))): 3032 (Ar-CH), 2922 (CH in CH\(_3\)), 1722 (C=O), 1520 (C=N), 1460 (C=C), 647 (C-S), 564 (C-Br). \(^1\)H-NMR (CDCl\(_3\)) \(\delta\): 7.21-7.97 (m, 9H; C\(_5\),C\(_6\),C\(_7\),C\(_8\),C\(_2''\),C\(_3''\),C\(_4''\),C\(_5''\),C\(_6''\); Ar-H), 4.34 (tet, 2H; -CH\(_2\)), 1.60-2.58 (m, 8H; C\(_4\),C\(_5\),C\(_6\),C\(_7\)), 1.37 (tri, 3H; -CH\(_3\)). EI-MS (m/z): 430 (C\(_{25}\)H\(_{22}\)N\(_2\)O\(_3\)S; 430.52). Anal. Calcd for C\(_{25}\)H\(_{22}\)N\(_2\)O\(_3\)S: C, 69.75; H, 5.15; N, 6.51. Found: C, 69.71; H, 5.12; N, 6.42.

6-Bromo-2-phenyl-3-(3-carbethoxy-4,5,6,7-tetrahydrobenzothiophene-2-yl)-quinazolin-4(3H)-one (7k):
IR (KBr, cm\(^{-1}\))): 3019 (Ar-CH), 2917 (CH in CH\(_3\)), 1726 (C=O), 1518 (C=N), 1454 (C=C), 649 (C-S), 577 (C-Br). \(^1\)H-NMR (CDCl\(_3\)) \(\delta\): 7.21-7.97 (m, 9H; C\(_5\),C\(_6\),C\(_7\),C\(_8\),C\(_2''\),C\(_3''\),C\(_4''\),C\(_5''\),C\(_6''\); Ar-H), 4.34 (tet, 2H; -CH\(_2\)), 1.60-2.58 (m, 8H; C\(_4\),C\(_5\),C\(_6\),C\(_7\)), 1.37 (tri, 3H; -CH\(_3\)). EI-MS (m/z): 509 (C\(_{25}\)H\(_{21}\)BrN\(_2\)O\(_3\)S; 509.41). Anal. Calcd for C\(_{25}\)H\(_{21}\)BrN\(_2\)O\(_3\)S: C, 58.94; H, 4.16; N, 5.50. Found: C, 58.90; H, 4.11; N, 5.47.

Anti-microbial activity:
Most of the synthesized compound exhibited mild to moderate anti-microbial activity against the tested microorganism. Compounds 7c and 7f were found to possess significant antibacterial and anti-fungal activity when compared to standard drug (Ciprofloxacin and...
Ketoconazole for anti-bacterial and anti-fungal respectively). The entire synthesized compound exhibited mild to moderate anti-microbial activity with an MIC range of 24.1 to 47.6 µg/ml.
Table-1: Physical data of the synthesized compounds

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<td>H</td>
<td>C₆H₅</td>
<td>C₁₁H₁₄O₂S</td>
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Table-2: Anti-microbial activity of the synthesized compounds(100 µg/ml)

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<tr>
<th>Compound</th>
<th>S.aureus</th>
<th>S.epidermidis</th>
<th>M.luteus</th>
<th>B.cereus</th>
<th>E.coli</th>
<th>P.aeuriginosa</th>
<th>K.pneumoniae</th>
<th>A.niger</th>
<th>A.fumigatus</th>
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<tr>
<td>7a</td>
<td>18(44.1)</td>
<td>20(33.7)</td>
<td>17(43.2)</td>
<td>15(41.3)</td>
<td>20(36.8)</td>
<td>14(38.7)</td>
<td>16(40.5)</td>
<td>13(43.4)</td>
<td>15(42.6)</td>
</tr>
<tr>
<td>7b</td>
<td>20(37.5)</td>
<td>23(28.3)</td>
<td>19(40.3)</td>
<td>18(39.7)</td>
<td>21(34.5)</td>
<td>17(39.4)</td>
<td>18(37.4)</td>
<td>14(32.3)</td>
<td>16(40.2)</td>
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<tr>
<td>7c</td>
<td>24(30.6)</td>
<td>27(24.1)</td>
<td>24(33.5)</td>
<td>21(36.4)</td>
<td>25(32.1)</td>
<td>20(37.6)</td>
<td>23(38.7)</td>
<td>20(37.7)</td>
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<td>7d</td>
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<td>17(37.6)</td>
<td>17(41.8)</td>
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<td>14(41.6)</td>
<td>11(45.8)</td>
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Out of the synthesized compounds, brominated derivatives exhibited more activity than unsubstituted one. In addition, thiazole derivatives exhibited more anti-bacterial activity than anti-fungal activity. Whereas, benzothiophene derivatives exhibited more anti-fungal activity than anti-bacterial activity.

REFERENCES

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